

*International Oil & Ice Workshop 2007*

# Shoreline Treatment In Arctic Environments

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# Topics

- Range of winter-arctic operating environments for oil spill planning and response



# Topics

- Shoreline treatment
  - behaviour of oil on shore ice and snow
  - documentation
  - response field guides and manuals
  - operational factors (waste management)

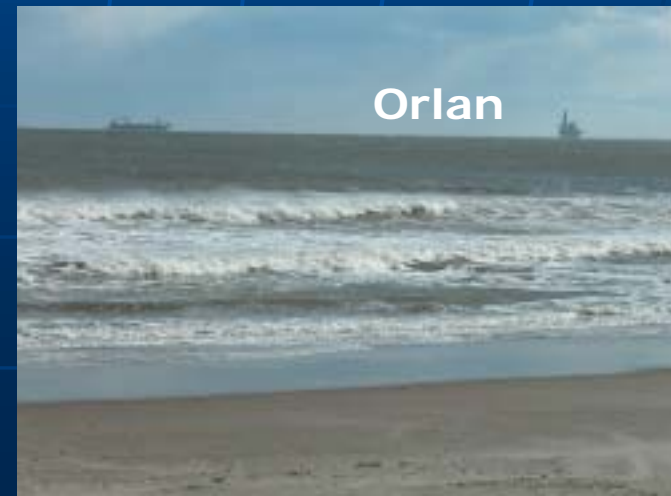




# Sakhalin 1 Project

**Faced with a range of winter operating environments for planning and response**

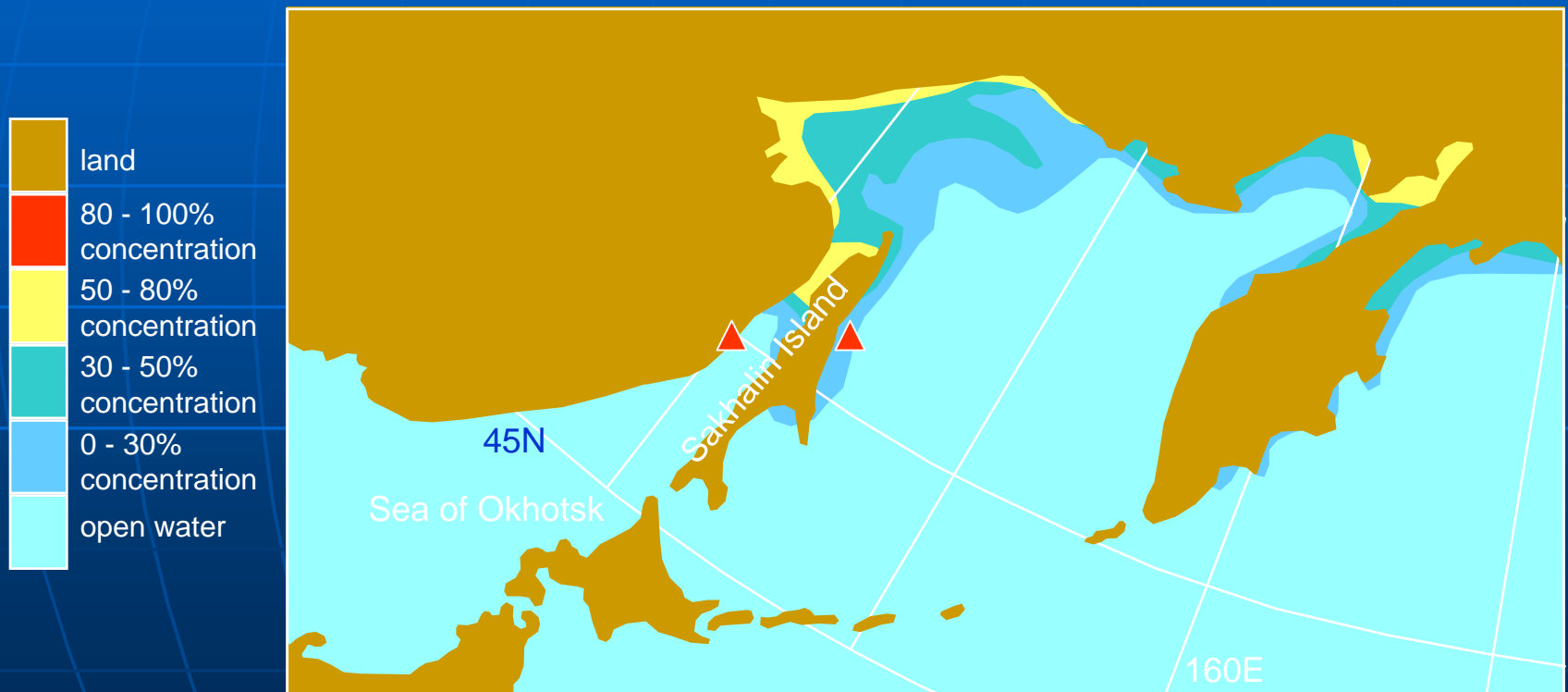
- Offshore production (Orlan)
- Subsea pipeline to shore
- Shore zone production (Chayvo)
- Subsea pipeline (Tartar Strait)
- Pipeline to SPM (DeKastri)
- SPM



Orlan

# Sakhalin - Sea Ice

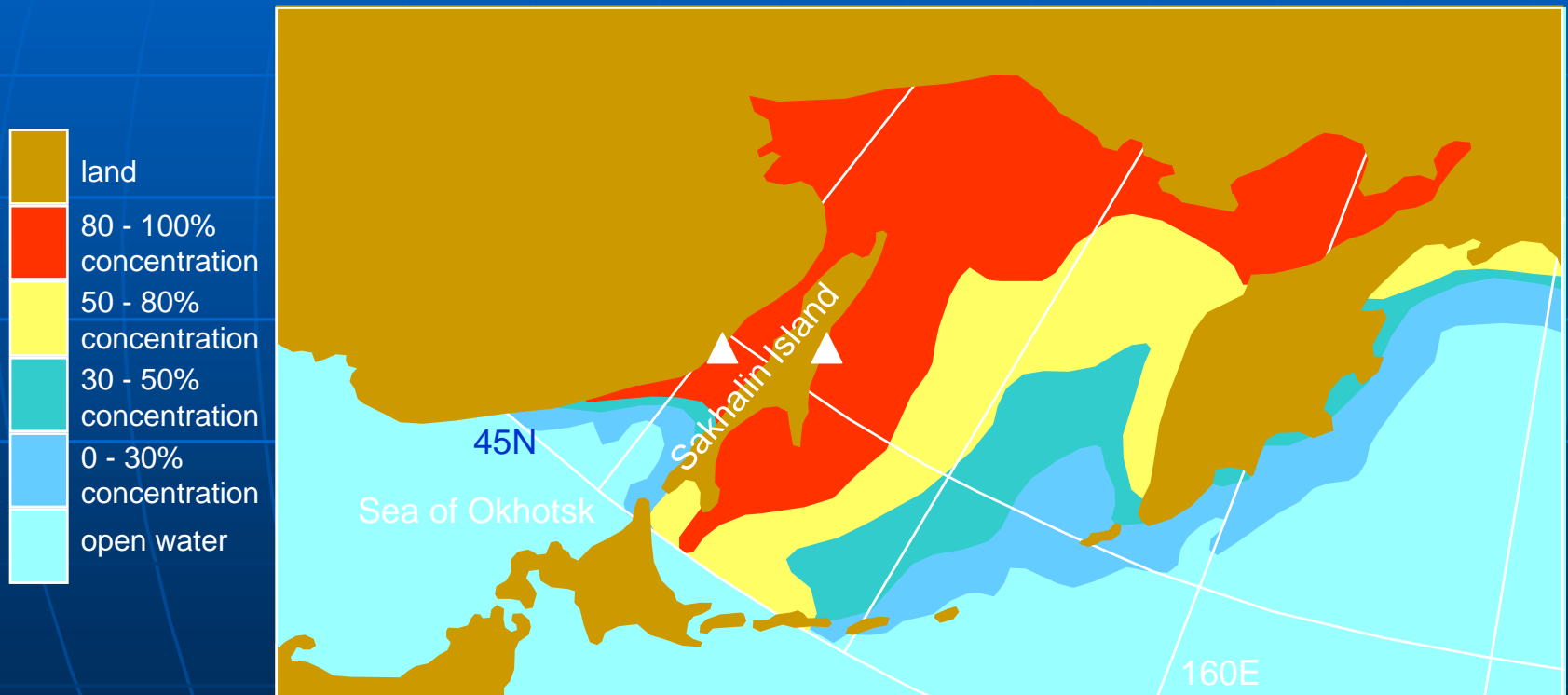
## Mean Ice Concentration - December 1





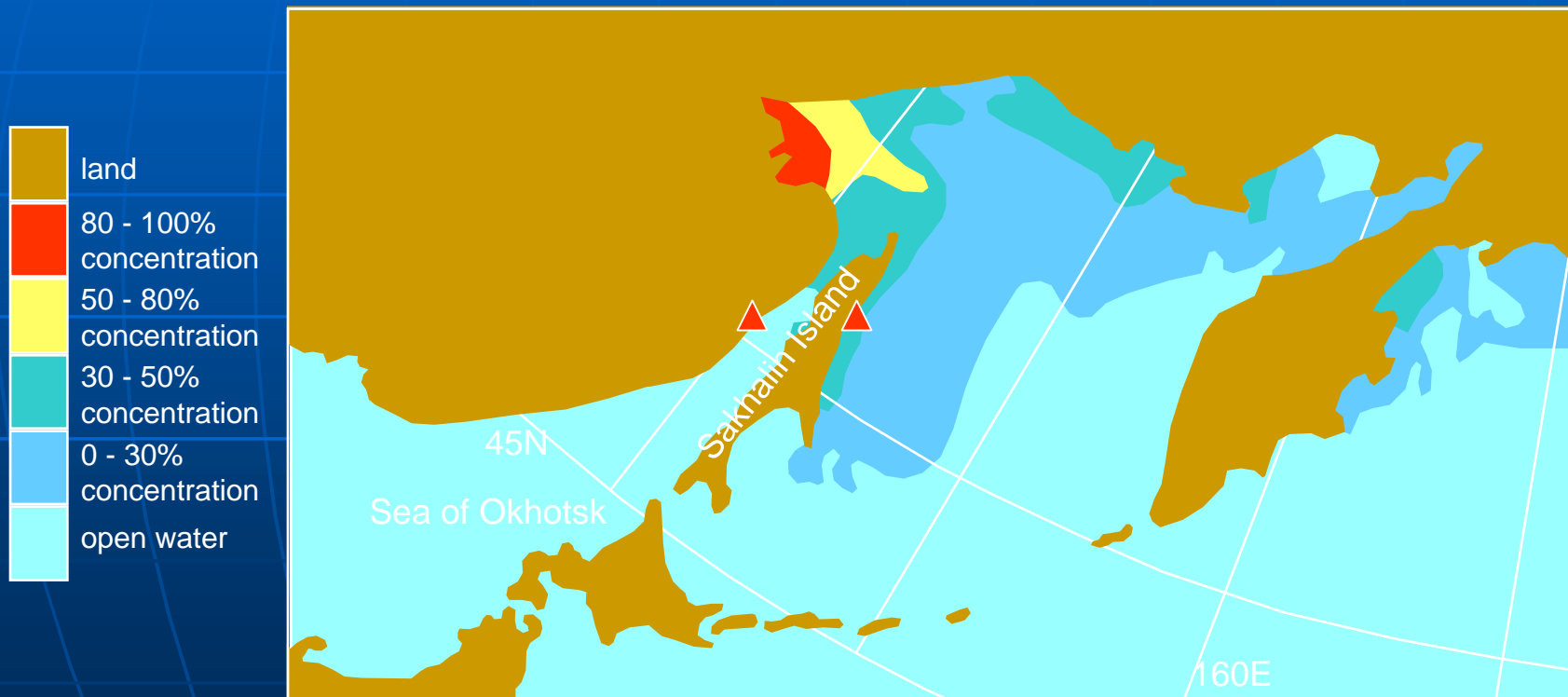
# Sakhalin - Sea Ice

## Mean Ice Concentration - March 1



# Sakhalin - Sea Ice

## Mean Ice Concentration - June 1



# Sakhalin Winter Operating-Response Environments

## NE Sakhalin – Orlan/subsea pipeline

- ice foot
  - land fast ice
  - offshore pack ice: highly mobile – highly variable (open water to open drift ice with 5/10 or less to 9+/10 very close pack)
- 
- freeze-up with 9/10 young ice: early – late December
  - open water with 5/10 or less: late May – late June
- average 195 days ice-free days



# NE Sakhalin

## Annual Coastal Processes Cycle

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
onshore average wind speed >4 m/s												
offshore winds >10 m/s		?	?									
coastal ice					breakup						freeze-up	
fog												
wave height >1.25 m (50%)		?	?	?								
air temperature >0 °C												



open water

land fast ice

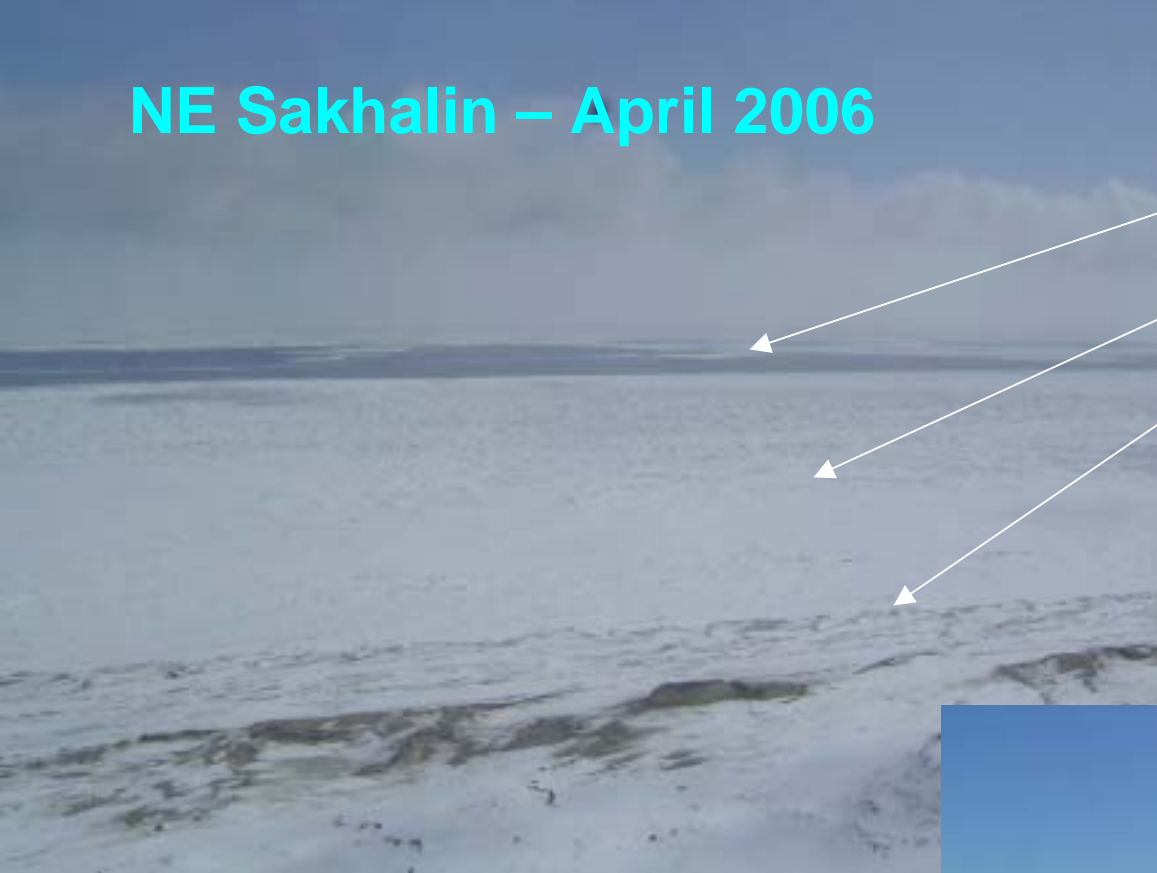
ice foot

land fast ice

**NE Sakhalin – January 2007**



# NE Sakhalin – April 2006



offshore 5/10 ice

land fast ice

ice foot

ice foot

active tidal inlet

50km to the north

open water



Chayvo Bay

# Sakhalin Winter Operating-Response Environments

## NW Sakhalin – Tartar Strait – subsea pipeline

- Ice foot
  - Land fast ice
  - Stable, solid ice cover
- 
- early November - first ice forms
  - by end Dec.- 9+/10 cover south to 48 deg N.
  - Jan-March - stable shore-fast ice forms in Northern Strait and in coastal bays
  - May-June – ice clears

## Tartar Strait – April 2006



# Sakhalin Winter Operating-Response Environments

## Mainland – DeKastri Marine Terminal

- ice foot
  - land fast ice
  - offshore - very open to open drift ice
- 
- early November: first ice forms
  - by end Dec: 10/10 cover up to 48 deg
  - Jan-March: stable shore-fast ice forms in Northern Strait and in coastal bays
  - May-June: ice clears



De Kastri - April



Somon Bay



# Arctic Shorelines

- For oil spill planning and response need to consider:
  - the physical character of the shore zone (ice and snow conditions), plus
  - near/offshore ice conditions
  - tidal range
- as well as the oil type and volume.



# Topics

## ■ Shoreline treatment

- behaviour of oil on shore ice and snow
- documentation
- field guides and manuals
- operational factors



# Oil in Snow Behavior (1)

- understand the basic principles
- do not adequately understand the mechanics of oil behaviour or transport mechanisms for predictive modeling, plus
- oil often is hidden from view, so
- it is difficult to estimate oil transport pathways and to anticipate where the oil will accumulate



# Oil in Snow Behavior (2)

Key factors in migration pathways are:

- snow thickness
- snow surface topography
- snow character and properties
- terrain slope
- presence of ice layers
- oil properties

A complexity that is not conducive to predictive modeling



# Oil in Snow Behavior (3)

- Nothing really new for the past 20 years – little research effort – little interest?
- Most of the effort has been on oil and sea ice.





# Oil and Shore Zone Ice

- Oil and ice behaviour basically is well understood for sea ice.
- Can theorize, but do not actually know, how oil interacts with shore zone ice
  - during freeze-up (ice foot formation),
  - with shore fast ice,
  - under ice in the zone of tidal ice hinge zone



# SINTEF 2007-2008 Winter Studies (1)

Introductory studies to better:

- understand winter shore zone dynamics
- document the formation and character of ice on typical northern shorelines

as the basis for further studies on icy shorelines.



# SINTEF 2007-2008

## Winter Studies (2)

- Environmental observations and data collection at two northern locations
- Evaluation of how long-term met. data can be applied to predict the frequency and duration of icing events
- Evaluation of how icing events can be predicted by correlating short-term local observations to long-term met. data

# Arctic Shoreline Treatment

## - Field Guides and Documentation

- 1996 Environment Canada "**Oiled Arctic Shorelines**" **Field Guide** is **in revision**
  - Marine, Lake, and River Manuals: with specific sections on shorelines with snow and ice
- 2004 Environment Canada **Arctic SCAT Manual**
- SINTEF "**Stranded Oil on Shorelines with Snow and Ice**" review May 2007

# SNOW

Tactic	Oil Type				
	Volatile	Light	Medium	Heavy	Solid
Natural Recovery	✓	✓	○		
Flooding	✓	✓	✓		
Low Pressure Ambient Wash	✓	✓	✓		
Low Pressure Warm Wash					
High Pressure Ambient Wash					
High Pressure Warm Wash					
Steam cleaning					
Sand Blasting					
Manual	○	○	○	○	○
Vacuums	○	✓	✓		
Mechanical	○	○	✓	✓	✓
Vegetation Cutting					
Passive Sorbents	○	○	○		
Mixing-wet	✓	✓	✓	○	
Mixing-dry					
Sediment Relocation	✓	✓	✓	○	
Burning	✓	✓	✓	○	
Dispersants					
Shoreline Cleaners					
Solidifiers					
Bioremediation					



# Shoreline Treatment Field Guides

## SHORE ICE

Tactic	Oil Type				
	Volatile	Light	Medium	Heavy	Solid
Natural Recovery	✓	✓	○		
Flooding	✓	✓	○		
Low Pressure Ambient Wash	✓	✓	✓	○	
Low Pressure Warm Wash			✓	○	
High Pressure Ambient Wash				○	
High Pressure Warm Wash					
Steam cleaning					
Sand Blasting					
Manual	○	○	○	○	○
Vacuums	○	✓	✓		
Mechanical	✓	✓	✓	✓	✓
Vegetation Cutting					
Passive Sorbents	○	○	○		
Mixing-wet					
Mixing-dry					
Sediment Relocation					
Burning	✓	✓	✓	○	
Dispersants					
Shoreline Cleaners					
Solidifiers					
Bioremediation					

**2004**

funded by  
**The Arctic Council**

# THE ARCTIC SCAT MANUAL

A Field Guide to the Documentation  
of Oiled Shorelines in Arctic Regions

**EPPR** Emergency Prevention  
Preparedness and Response  
A Program of the Arctic Council



# 2004 Arctic SCAT Manual

- Introduced **standard terms and definitions** for shore-zone snow and ice character
- Described shore types that are unique to the arctic
- **Snow and Ice Job Aid**



- Arctic-winter SCAT forms
- Provided “First Responder” short form

# Snow and Ice Terminology

snow **SNW**

frozen swash **FSW**

frozen spray **FSP** →

ice foot **IFT**

ice-push ridge **IPR**

grounded floes **GFL**

glacier ice **GLC**



# Inundated Low-lying Tundra





# Ice-Rich Tundra Cliffs



# Decision Process

- SCAT provides relevant information on shorelines and oil conditions.
- The decision process then has to focus on environmental and operational factors that are critical to arctic regions.



# Decision Process

## - Operational Factors in the Arctic

### ■ **Location - Remoteness**

- logistics support
- waste minimization

### ■ **Treatment Endpoints**

- treatment techniques/effort
- waste generation

### ■ **Environment and Human Use**

- seasonal sensitivity/vulnerability



# Arctic Council EPPR - Work In Progress

- Developing a **Decision Guide** and **Job Aids** for **waste management** in the Arctic.
- Focus is on those considerations that are integral to the selection of practical and feasible strategies and tactics.
- These considerations are very different for “remote areas” and for arctic regions.

# Concept

- Involves a realignment of standard concepts.
- Requires a shift from those strategies that apply to populated and/or accessible areas with a
- Strong emphasis on *in situ* offshore and onshore treatment options.



# Approach

- Provide **tools for decision makers** that illustrate the consequences of different strategy decisions.
- Present guidelines in a **non-technical format**.
- Explain how **policy decisions** affect waste generation (e.g. with respect to treatment end points).

# PART 1 - WASTE MANAGEMENT STRATEGIES

*"step-wise approach on how to make decisions"*

**1.1 Waste Generation** *(policy input)*

**1.2 Waste Types** *(input to Job Aid tool)*

**1.3 Waste Volumes** *(input to Job Aid tool)*

Completed in March 2007

# PART 1 - WASTE MANAGEMENT STRATEGIES

## 1.1 Waste Generation

- information requirements for the decision process
  - step 1: selection of treatment end points
  - step 2: selection of treatment methods
- two decision levels: regional and segment specific

## 1.2 Waste Types

by different treatment methods, oil types, shore types, and spill sizes for oiled snow, ice, wildlife, etc.

## 1.3 Waste Volumes

by different treatment methods, oil types, shore types, and spill sizes

# PART 2 - WASTE MANAGEMENT OPERATIONS AND TECHNIQUES

*"what to do and how to implement the decisions"*

## 2.1 Waste Handling

## 2.2 Waste Transfers

## 2.3 Waste Disposal

Next phase





# PART 2 - WASTE MANAGEMENT OPERATIONS AND TECHNIQUES

## 2.1 Waste Handling

- classification, segregation, packaging, labeling, temporary storage
- including oil/water separation and seasonal factors (e.g. oil on ice)
- advantages and disadvantages of each option

## 2.2 Waste Transfers

(between generation and disposal)

- primary, secondary, and tertiary storage

## 2.3 Waste Disposal

- Is the objective to bury, eliminate or recycle?
- onsite and offsite
- permanent disposal
- applicability, advantages, disadvantages, and cost implications of each option

## PART 3 – COUNTRY-SPECIFIC TOPICS

*"how does the decision process and implementation of a plan apply to a specific country – what are the key geographic considerations"?*

- The key administrative, jurisdictional, and land management procedures (organized in sections for each participating country)

Canada completed in March 2006

## PART 4 – TOOLS AND JOB AIDS

Recommended detailed **Table of Contents** for the Waste Management section of on Oil Spill Contingency/Response Plan.

**Computer calculator/tool** for decision makers that inputs:

- shore type,
- oil type,
- oil volume,
- selected treatment tactic,
- treatment end point, and
- disposal method

and provides comparative:

- *waste volumes,*
- *waste types, and*
- *transfer costs*



Final phase

# Summary (1)

- Many different aspects to oil on shore ice and snow – as there are with all of the other shoreline types.
- Despite the variability, **the treatment response options are straightforward and the decision process is not complicated but is poorly understood.**

# Solutions

Develop better field tools as well as SOPs or Rules of Thumb for **delineation** of oil in shore ice and snow.

For the wide range of

- shore ice and snow conditions
- nearshore ice/open water situations
- oil types

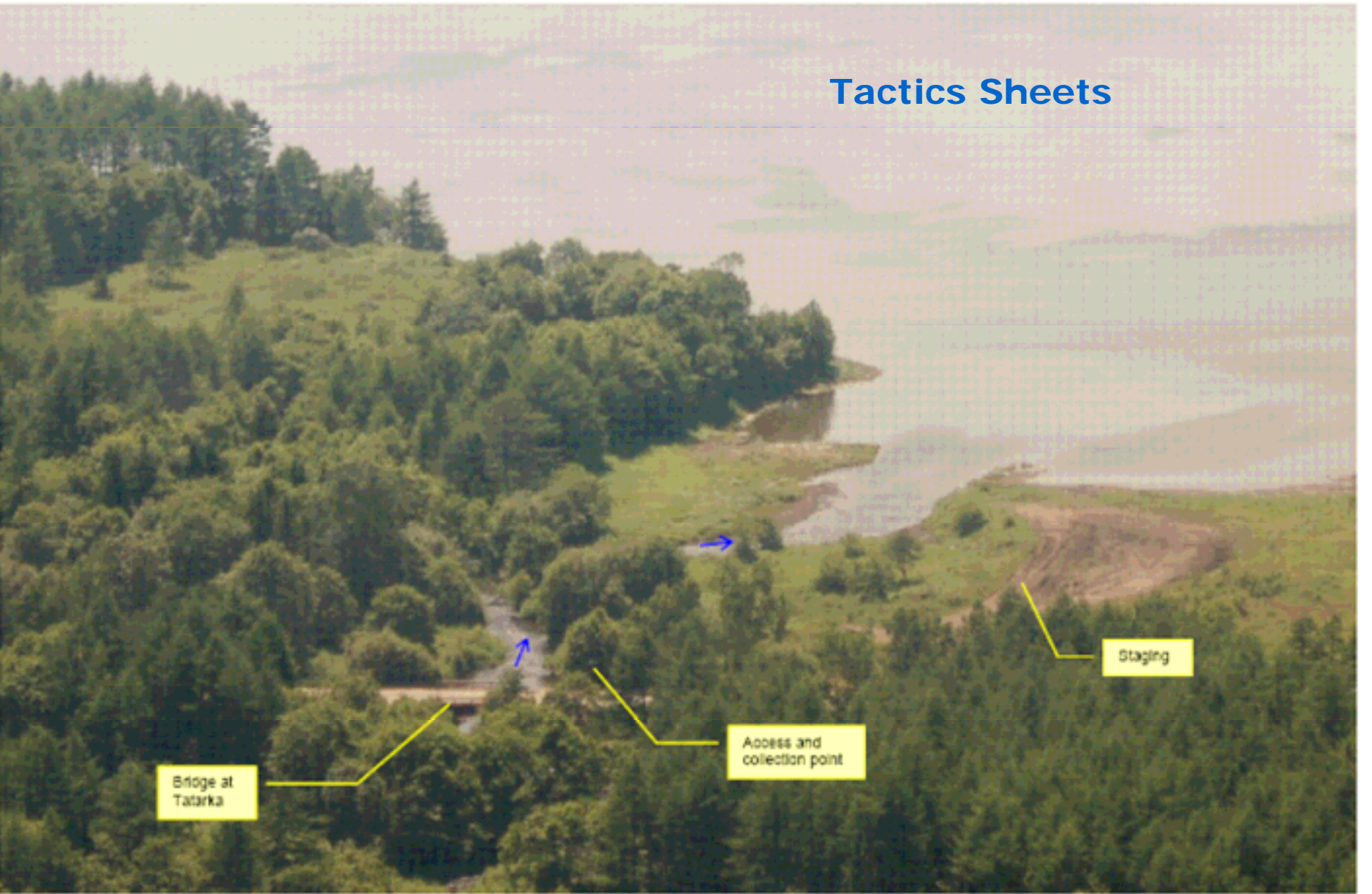
develop scenarios and generic tactics sheets for planning and training.

# Ice and Snow Condition Scenarios

- **Stranded ice floes** or blocks on a pebble cobble beach
- Newly forming **ice foot** with open water nearshore
- Open water with **freezing splash and spray**
- Mid-winter with **ice foot, tidal cracks, and solid floating nearshore ice**
- Spring **thawing ice foot** with open water nearshore
- **Deep backshore-supratidal snow cover** (2.0m) with nearshore open water
- *etc. etc. for different oil types*

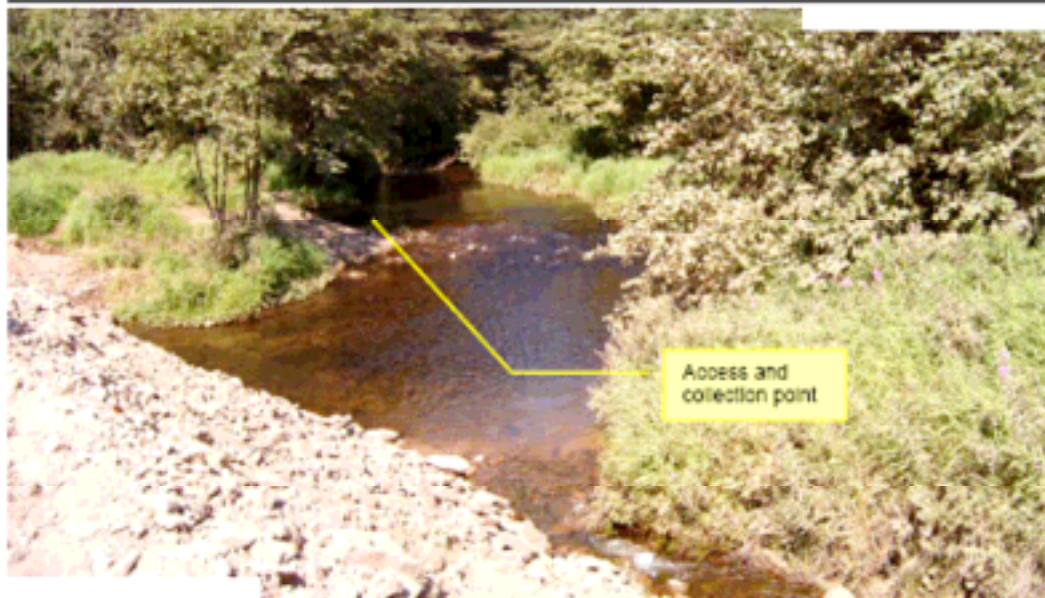


Tactics Sheets



Aerial view of Tatarka bridge and access (upstream and downstream) from west end of bridge. Staging area for river or beach operations. (July 2006)





View upstream from road bridge over Tatarka (July 2006)



View of diversion shoreseal boom and skimmer collection point at upstream access to Tatarka (July 2006).



View downstream from road bridge over Tatarka (July 2006)



View of diversion shoreseal boom and skimmer collection point at downstream access to Tatarka (July 2006).





View of staging area and bay access (April 2006)



View of upstream side of bridge and road to terminal (April 2006)



View of upstream side of the Tatarka at bridge (April 2006)



View of downstream side of Tatarka at bridge (April 2006)

# Summary (2)

For spill response strategy planning, transfer what we already know about oil in shore ice and snow to the decision process in terms of:

- locating oil,
- feasibility and practicality of treatment, and
- waste management (including ice/snow melting).

# Summary (3)

## Is there anything else that we need to know or do?

- Behavior of oil in snow and ice on shorelines is basically understood, but...
- know very little about how oil interacts at the shoreline in different ice and snow conditions (e.g. freezing vs. thawing ice foot) with the different ice and snow forms.
- **Transport processes and detection** are poorly understood and offer opportunities for improving response capabilities.

# Shoreline Treatment In Arctic Environments

- The response and removal techniques for snow-ice conditions are basically well understood.
- Improvements and progress are more a function of:
  - understanding the **behaviour and fate** of oil on snow and ice in the shore zone,
  - **locating oil** in shore ice and snow, and
  - using the **right tools** in the decision process.



